Competency 4.4 **Radiation protection personnel shall demonstrate the ability to effectively communicate the hazards associated with exposure to ionizing radiation.**

1. SUPPORTING KNOWLEDGE AND /OR SKILLS

a. Discuss the essential elements of effective hazard communication.

b. Explain the health physicist's mission of protecting workers, the public, and the environment from unnecessary exposure to ionizing radiation.

c. Describe how an explanation of the following can be used to effectively communicate hazard:
   - Comparing occupational dose limits to natural background radiation
   - Developing comparisons to commonly accepted hazards that puts radiation exposure at a site in perspective.

d. Explain how excessive hazard avoidance can be costly, and wasteful.

e. Discuss other job-related mortality statistics and how they compare with the risk of mortality from jobs which have occupational exposure to radiation.

f. Explain how to use the following techniques in the context of radiation hazard communication:
   - Listening skills
   - Tone of voice
   - Body language, eye contact
   - Analogies, illustrations, demonstrations
   - Real-life experiences

g. Participate in hazard-communication activities with peers, Department management, or contractor personnel.

2. SUMMARY

Elements of Effective Hazard Communication

Effective hazard communication is important because of the high level of fear associated with ionizing radiation and nuclear power plants. The fact that many citizens believe they are at great risk today indicates that radiation risk communication has a long way to go. Health physicists must be able to relate the message to the audience's perspectives: reflect the perspective, technical capacity, and concerns of the audience. The media also play an important role because they can heavily influence public perceptions about risks and they can instigate concern or draw attention to neglected or unappreciated risks.

A community may have a magnified perception of radiation risk. If the people in a community believe that a local facility has put them at risk through the release of pollutants, a sense of outrage inevitably follows. Studies of public perceptions of risk have shown that factors that lead to anger include: involuntary exposures, lack of previous knowledge of the risk, dread of the effects, and severe consequences. It has been pointed out that the dreaded and unfamiliar nature of environmental (nonmedical) exposure to ionizing radiation has evoked even greater fear of radiation than exposure to hazardous chemicals.

In the study, *Improving Risk Communication*, the National Research Council identified four process objectives that are key to improving risk communication. These are general recommendations which pertain to the process that an organization should use to generate decisions concerning risk messages. This reference also provides guidance on the content of risk messages.

Realistic Goals Program goals should be established that explicitly address the public communication between the radiological program and associated risks to the community. By doing this up front, the program can have realistic plans for public responses, and motives. If the risk communication program is insensitive to the community, any preexisting tensions could be heightened.

Openness People can be more interested in matters of trust, credibility, and fairness than in technical details of risk estimates. If interested groups are brought in late, they are more likely to be frustrated if decisions have been made and are off-limits for discussion. When risk factors are discussed behind closed doors, or when health physicists have a patronizing attitude toward interested outside groups, communication efforts can fail because public trust and credibility can be damaged.

An effective dialogue with affected outsiders should be maintained and a spirit of early, sustained, and open exchange exhibited. Productive interaction is achieved when outside parties are treated like fully legitimate participants. Radiation protection risk communicators should be good listeners and should not make prejudgements about what people think and know. They should be prepared for skepticism, antagonism, and hostility.

Accuracy Radiation risk estimates should be presented in a balanced and accurate manner. All efforts should be made to prevent real or perceived distortion and bias in the communication. It may be difficult to ascertain whether the listener will be misled. A few ideas to ensure that a communication or message is not distorted include, conducting an independent review of the message or preparing a formal "white paper" that can be generally released. It is always helpful to have written supporting documents available.

Competence Excluding technical expertise can lead to an incomplete message or the appearance of willful manipulation of the facts. Excluding public concerns provides a danger of insensitivity to the capacities, interests, and needs of the listener. An assessment of the audience, using surveys or questionnaires, can compile a profile of their concerns. Then scientific accuracy and completeness can be ensured.

The manner of radioactive waste management depends on scientific criteria including activity level, half-life, physical quantity, and physical form. However, sociopolitical considerations, such as the "not in my backyard" (NIMBY) syndrome and the degree of public acceptance of scientifically-based public policy decisions, are also improtant. The general public may not understand that waste materials whose activity, quantity, or concentration does not exceed regulatory lower limits are indeed radioactive from a physical point of view, but are not hazardous because of their low levels of activity. It is important to inform the public in a simplified manner that these waste materials pose little health risk.

Mission of the Health Physicist

Health physics is a profession with the goal of protecting the public from the harmful effects of ionizing (and nonionizing) radiation. The radiation protection specialist should keep the population and environment under continual surveillance to ensure that radiation doses will be minimized and kept within acceptable limits at all times. This requires the maintenance of safety aspects in the design of processes, equipment, and facilities using radioactive sources or generating devices.

The following paragraphs include excerpts from technical documents including the positions of the Department of Energy and the Health Physics Society regarding radiological protection:

DOE P441.1, *Department of Energy Radiological Health and Safety Policy*

It is the policy of DOE to conduct its radiological operations in a manner that ensures the health and safety of all its employees, and the general public. In achieving this objective, the Department shall ensure that radiation exposures to its workers and the public and releases of radioactivity to the environment are maintained below regulatory limits and deliberate efforts are made to further reduce exposures and releases as low as reasonably achievable (ALARA). The Department is fully committed to implementing a radiological control program of the highest quality which consistently reflects this policy.

***Radiological Control Manual,* Part 1, Article 111**

A key element of the *Radiation Protection Guidance to the Federal Agencies for Occupational Exposure* approved by President Reagan on January 20, 1987, and a fundamental principle underlying this Manual is:

> *"There should not be any occupational exposure of workers to ionizing radiation without the expectation of an overall benefit from the activity causing the exposure."*

DOE is firmly committed to having a radiological control program of the highest quality. This applies to those DOE activities that manage radiation and radioactive materials and that may potentially result in radiation exposure to workers, the public and the environment.

DOE's radiological control policy, shown below, summarizes the elements of the DOE's radiological health and safety policy and is intended to guide the actions of every person involved in radiological work throughout the Department.

Department of Energy Radiological Control Policy

ALARA
Personal radiation exposure shall be maintained ALARA. Radiation exposure of the workforce and public shall be controlled such that radiation exposures are well below regulatory limits and that there is no radiation exposure without commensurate benefit.

OWNERSHIP
Each person involved in radiological work is expected to demonstrate responsibility and accountability through an informed, disciplined, and cautious attitude toward radiation and radioactivity.

EXCELLENCE
Excellent performance is evident when radiation exposures are maintained well below regulatory limits, contamination is minimal, radioactivity is well controlled, and radiological spills or uncontrolled releases are prevented.

Continuing improvement is essential to excellence in radiological control.

Health Physics Society Prospectus

The Health Physics Society is a professional organization dedicated to the development, dissemination, and application of both the scientific knowledge of, and the practical means for, radiation protection. The objective of the Society is the protection of people and the environment from unnecessary exposure to radiation. The Society is thus concerned with understanding, evaluating, and controlling the risks from radiation exposure relative to the benefits derived.

The activities of the Society are those appropriate to the accomplishment of the purpose and objective including: 1) promoting cooperation and communication among people engaged in radiation protection activities within particular geographic or functional areas and technical specialties throughout chapters and sections; 2) providing for the dissemination and exchange of information through scientific and professional meetings, education, and publications; 3) encouraging scientific, professional, and public education; 4) promoting scientific research; 5) encouraging and supporting the development and use of radiation protection standards and recommendations; and 6) pursuing other activities appropriate to radiation protection.

Radiological Exposure Comparisons

Radiological risk comparisons should help to convey the nature and magnitude of a particular risk estimate. Most people do not easily relate low-risk probabilities or ratios, such as "one-in-a-million" to their everyday experience. One solution is to make quantitative comparisons between familiar and less familiar risks with the use of analogies. For example, one-in-a-million is equivalent to 30 seconds a year, one inch in 16 miles, one drop in 16 gallons. Another effective comparison is to contrast different agents that produce similar effects, such as the risk of lung cancer from inhaling radioactive radon particles versus smoking a particular number of cigarettes.

Regardless of whether scientists have rated nuclear power as safe, generally, the public still believes it to be highly risky. Although scientists rate riding motorcycles, smoking, or sunbathing as hazardous; other people consider those to be less risky activities. Researchers have identified general rules that may explain how we perceive risks:

1. Natural occurring risks seem less frightening. For example, people fear nuclear power, but are less fearful of the radioactive dangers of natural indoor radon gas.
2. Risks that have been imposed on us seem greater than risks we take on ourselves. Smoking cigarettes or sunbathing is a personal decision, but if a nuclear facility is placed near our home, we may feel powerless.
3. Risks with obvious personal benefits seem less distressing. For example, the general public will accept having an x-ray because of the perceived health benefit.
4. Risks associated with complex technologies and potential catastrophes appear to be greater. The media enhances this perception by focusing on catastrophes.

Job-Related Mortality Statistics

According to the Biological Effects of Ionizing Radiation Committee V, (BEIR V), the risk of cancer death is 0.08% per rem for acute doses and might be 2 to 4 times less than that for chronic doses. This is an uncertain estimate average for all ages, males and females, and all forms of cancer.

For a helpful and simplified explanation of risk comparisons, see the following web page:

http://www.sph.umich.edu/group/eih/UMSCHPS/risk.htm

A way to visualize risk is to look at the number of "days lost" out of a population, due to early death from other, more familiar, causes.

Health Risk	**Estimated Life Expectancy Lost***
Smoking 20 cigarettes a day	6 years (y)
Overweight (15%)	2
Alcohol (US average)	1
All accidents	207 days (d)
All natural hazards	7
Occupational dose (300 mrem/yr)	15
Occupational dose (1 rem/yr)	51

You can also use the same approach to looking at risks on the job:

Industry Type	**Estimated Life Expectancy Lost***
All industries	60 days (d)
Agriculture	320
Construction	227
Mining and quarrying	167
Manufacturing	40
Occupational dose (300 mrem/yr)	15
Occupational dose (1 rem/yr)	51

*These are estimates taken from the NRC Draft guide DG-8012 and were adapted from B. L. Cohen and I. S. Lee, "Catalogue of Risks Extended and Updates", *Health Physics*, Vol. 61, September 1991.

Another way of looking at risk, is to look at:

Relative risk of one-in-a-million chances of dying from activities common to our society (adapted from DOE Radiation Worker Training, based on work by B.L. Cohen, Sc.D)

- Smoking 1.4 cigarettes (lung cancer)
- Eating 40 tablespoons of peanut butter
- Spending 2 days in New York City (air pollution)
- Driving 40 miles in a car (accident)
- Flying 2,500 miles in a jet (accident)
- Canoeing for 6 minutes (accident)
- Receiving 10 mrem of radiation (cancer)

The following is a comparison of the risks of some medical exams and is based on the following information:

- Cigarette smoking - 50,000 lung cancer deaths each year per 50 million smokers consuming 20 cigarettes a day, or one death per 7.3 million cigarettes smoked, or 1.37×10^{-7} deaths per cigarette.

- Highway driving - 56,000 deaths each year per 100 million drivers, each covering 10,000 miles; or one death per 18 million miles driving; or 5.6×10^{-8} deaths per mile driven.
- Radiation induced fatal cancer - 4% per sievert (100 rem) for exposure to low doses and dose rates.

Procedure	Effective Dose (mrem)	Risk of Fatal Cancer	Equivalent to Number of Cigarettes Smoked	Equivalent to Number of Highway Miles Driven
Chest Radiograph	3.2	1.3×10^{-6}	9	23
Skull Exam	15	6×10^{-6}	44	104
Barium Enema	54	2×10^{-5}	148	357
Bone Scan	440	1.8×10^{-4}	1300	3200

Adapted from information in *Radiobiology for the Radiologist*, (4th ed.), Eric Hall 1994, J.B. Lippincott Co.

The following is a comparison of limits, doses and dose rates from many different sources. Most of this data came from *Radiobiology for the Radiologist* or BEIR V, National Academy of Science. Ranges have been given if known. All doses are total effective dose equivalent (TEDE) unless otherwise noted. The doses for x-rays are for the years 1980-1985 and could be lower today.

Doses from Various Sources:

Limits for Exposures	**Exposure (mrem/yr)**
Occupational dose limit (NRC) and DOE	5,000
Occupation exposure limits for minors	500
Occupational exposure limits for fetus	500
Public dose limits due to NRC license activities or DOE activities	100
Occupational limits (eye)	15,000
Occupational limits (skin)	50,000
Occupational limits (extremities)	50,000

Source of Exposure	**Exposure (mrem/yr)**	**Range**
Average dose to US public from all sources	360	
Average dose to US public from natural sources	300	
Average dose to US public from medical sources	53	

Average dose to US public from weapons fallout	< 1	
Average dose to US public from nuclear power	< 0.1	
Coal burning power plant	0.165	
X-rays from TV set (1 inch)	0.500 mrem/hr	
Airplane ride (39,000 ft)	0.500 mrem/hr	
Nuclear power plant	0.600	
Natural gas in home	9	
Average natural background	0.008 mR/hr	0.006-0.015 mR/hr
Average US terrestrial radiation	28	
Terrestrial background (Atlantic coast)	16	
Terrestrial background (Rocky Mountains)	40	
Average U.S. cosmic radiation	27	
Cosmic radiation (sea level)	26	
Cosmic radiation (Denver)	50	
Background radiation total (east, west, central U.S.)	46	35-75
Background radiation total (Colorado Plateau)	90	75-140
Background radiation total (Atlantic and Gulf in U.S.)	23	15-35
Radionuclides in the body (i.e., potassium)	39	
Building materials (concrete)	3	
Drinking water	5	
Pocket watch (radium dial)	6	
Eyeglasses (containing thorium)	6-11	

Source of Exposure	**Exposure (mrem)**	**Range**
Coast to coast airplane round-trip	5	
Chest x-ray	8	5-20
Extremities x-ray	1	
Dental x-ray	10	
Head/neck x-ray	20	
Cervical spine x-ray	22	
Lumbar spine x-ray	130	
Pelvis x-ray	44	
Hip x-ray	83	
Shoe fitting fluoroscope (used during the 1960's)	170	
Upper GI series	245	
Lower GI series	405	
CT (head and body)	1100	
Therapeutic thyroid treatment (dose to the thyroid)	10,000,000 mrad	
Therapeutic thyroid treatment (whole-body)	7000	5,000-15,000 mrad
Earliest onset of radiation sickness	75,000 mrad	

Onset of hemopoietic syndrome	300,000 mrad	100,000-800,000 mrad
Onset of gastrointestinal syndrome	1,000,000 mrad	500,000-1,200,000 mrad
Onset of cerebrovascular syndrome	10,000,00 mrad	>5,000,000 mrad
Threshold for cataracts (dose to the eye)	200,000 mrad	
Expected 50% death without medical attention	400,000 mrad	300,000-500,000 mrad
Doubling dose for genetic effects	100,000 mrad	
Doubling dose for cancer	500,000 mrad	(8% per Sv, natural level at 20%)
Dose for increase cancer risk of 1 in 1,000	1,250	(8% per Sv)
Consideration of therapeutic abortion threshold (dose in utero)		10,000
SL1 Reactor accident, highest dose to survivor	27,000	
Three Mile Island (dose at plant, duration of the accident)		80

Hazard Communication Techniques

People interpret and use new information in the context of their existing beliefs. A basic understanding of exposure and effect is needed in order for the public to be able to make an assessment about a radiologically hazardous process, product, or site. Those needs should be met through effective hazard communication techniques. Communication means both listening and speaking. Health physicists should learn about the concerns and values of their audience, their relevant knowledge, and their experience with radiological risk issues. Trust is key for effective correspondence and cooperative action. By listening, radiation protection specialists can better reflect the perspectives, technical knowledge, and concerns of the audience. When communicating with the public, preparations must be made to explain and answer questions about any specific, relevant tests or surveys done in the community regarding incidences of illness or radiological uptakes; they should not rely on general models. Effective communication must begin before important decisions have been made.

The following are a few relatively simple and generally supported statements about human behavior which are outlined in the essay *Risk: A Guide to Controversy,* written by Baruch Fischhoff. These observations can give communicators insight on how people may perceive the risks associated with ionizing radiation:

- People simplify. To comprehend analytical solutions or too much information, people will rely on habit, tradition, advice of neighbors or media, and general rules of thumb. People may attempt to divide participants in risk disputes as good guys and bad guys.

- Once people's minds are made up, it is difficult to change them. People will remain faithful to their views unless they are confronted with concentrated overwhelming evidence to the contrary.

An example of this behavior pattern is given in the following excerpt from the aforementioned document:

"..., the incident at Three Mile Island would have strengthened the resolve of any antinuclear activist who asked only, 'how likely is such an accident, given a fundamentally unsafe technology?,' just as it would have strengthened the resolve of any pronuclear activist who asked only, 'how likely is the containment of such an incident, given a fundamentally safe technology?.' Although a very significant event, Three Mile Island may not have revealed very much about the riskiness of nuclear technology as a whole. Nonetheless, it helped the opposing sides polarize their views. Similar polarization has followed the accident at Chernobyl, with opponents pointing to the 'consequences of a nuclear accident' (which come with any commitment to nuclear power) and proponents pointing to the unique features of that particular accident (which are unlikely to be repeated elsewhere, especially considering the precautions instituted in its wake)."

- People remember what they see. Most people's primary sources of information about risks are what they observe on the news. Therefore, people's estimates of risk are strongly related to the amount of media coverage devoted to them.

- People cannot readily detect omissions in the evidence they receive. When risk information is given to the general public, it may not be readily observable if blatant lies or unreasonable scientific disregard are present. The information that reaches the public may be true, but only partly true. People's risk perceptions can be manipulated by selective presentation.

- People may disagree more about what a risk is than about how large it is. An idea has circulated that the public cares much more about multiple deaths from large accidents than about equivalent numbers of casualties resulting from a series of small accidents, but there have been no empirical studies to determine if this is how the public defines risk. Studies have suggested that what concerns the public about catastrophic accidents is the perception that a technology capable of producing such accidents cannot be very well understood or controlled.

Some pointers on effective risk communication techniques:

- Be prepared: Plan your risk communication strategy carefully. Assess your audience's knowledge and experience with radiation, and the kinds of information that may be required to carry your message. Develop a clear set of objectives for your communication program. Consider and anticipate objections that your audience may have to your message. Practice your message and presentation.

- Establish trust and credibility. First establish trust, THEN discuss risk and technical issues. Trust is difficult to establish (easy to lose), but can be enhanced by being empathetic to your audience (recognize their legitimate concerns); being honest and open, and admitting when you do not know the answer; and listening to and respecting your audience. Fundamentally, you establish trust by being trustworthy. Establishing credibility comes by not trivializing any risks that do exist, and being technically prepared. Know the facts about each particular situation and its potential hazards.

- Keep it simple. The public typically wants to know, "Is it safe?" A simple "yes" or "no" is often enough. You may not need to present quantitative data or comparisons. Beware of burying the audience in data that they may not understand, this could lead to suspicions that you are trying to mislead them. Avoid jargon and technical "mumbo jumbo." Define any terms, concepts, acronyms, and scientific notation you use.

- Be careful with risk comparisons. Public audiences are frequently unimpressed by comparisons with other everyday risks they face. If you must make comparisons, some possible comparisons include: the same risk at two different times; the risks of doing something versus not doing it; alternative solutions to the same problem; and risks from similar situations experienced in other places.

3. SUGGESTED ADDITIONAL READINGS AND/OR COURSES

<u>*Readings*</u>

- *Improving Risk Communication,* National Research Council, National Academy Press, Washington, DC, 1989.
- DOE P441.1*, Department of Energy Radiological Health and Safety Policy*.
- DOE/EH-0256T (Revision 1)*, DOE Radiological Control Manual.*
- *Risk Assessment and Risk Management In Regulatory Decision-Making, Final Report, Volume 2,* The Presidential/Congressional Commission on Risk Assessment and Risk Management, 1997.
- *The Health Physics Society s Newsletter*. Ray Johnson, Communication Sciences Institute, April 1996, June 1996, September 1996, December 1996, April 1997.
- *Improving Risk Communication,* Appendix C*; Risk: A Guide to Controversy*, Baruch Fischhoff.
- Discovery Online, The Skinny On... Peanut Butter and Nuclear Power, *http://www.discovery.com/area/skinnyon/skinnyon970212/skinny.html*.
- The Radiation and Health Physics Home Page, SPH, University of Michigan, *Radiation and Risk. http://www.sph.umich.edu/group/eih/UMSCHPS/risk.htm*
- Health Physics Society Prospectus.
- Cember, Herman. *Introduction of Health Physics,* 3rd ed., McGraw-Hill.
- International Commission on Radiological Protection. *Cost-Benefit Analysis in the Optimization of Radiation Protection* (ICRP 37). New York: Author.
- Pacific Northwest Laboratory. (1988). *Department of Energy Health Physics Manual of Good Practices for Reducing Radiation Exposure to Levels that are As Low As Reasonably Achievable (ALARA)* (PNL-6577). Richland, WA: Author
- Haroun, Lynne & MacDonell, Margaret. *Risk Communication and Public Involvement, Training Course*, *Managing Human Health and Ecological Risk Assessment Projects Under CERCLA and RCRA*, developed by Argonne National Laboratory and sponsored by DOE.